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Cite as: AIP Conference Proceedings **2083**, 040002 (2019); <https://doi.org/10.1063/1.5094322>
Published Online: 21 March 2019

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Workability of Sintered Aluminium Composite Preforms of Varying Cu and TiC Contents during Cold Deformation

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Abstract. The present research investigates the workability behaviour of sintered Aluminium (Al) composites under cold deformation. Workability measures the level of deformation that materials can sustain prior to failure in the forming process. The effects of different weight percent of Copper (Cu) and Titanium carbide (TiC) addition to the Al composite preforms were experimentally determined. Al, Al-3%Cu, Al-3%Cu-2%TiC and Al-3%Cu-4%TiC were cold upset under different frictional conditions (nil/no lubricant, graphite lubricant and zinc stearate lubricant) and aspect ratios (0.45 and 0.9) to determine the workability behaviour. The curves were plotted and analysed for different preforms. The effects of the reinforcement addition to the Al composite and initial preform geometry on the relative density (R), and other influencing physical parameter such as axial stress and the formability stress index, β is presented.

INTRODUCTION

Aluminium (Al) and its composites are very versatile materials suitable for structural, automotive, aerospace and other high temperature and strength applications [1]. Composites are a material system composed of discrete constituents (the reinforcement) distributed in a continuous phase (the matrix). Metal Matrix Composites (MMC's) are intended to have enhanced properties such as high specific strength and stiffness, greater strength to weight ratios even at elevated temperatures with proper design and fabrication [2]. Hence, the workability characteristics of the material is of absolute importance as Powder metallurgy (PM) parts contain pores and this limits to a critical working density in order to produce healthy parts. Workability or formability examines the extent the material can be deformed before failure and the forming limit is an important criterion in the metal forming process. Thus, workability analysis will aid the secondary deformation process which is highly required in the PM process to further increase the material strength via secondary deformation process. Abdel-Rahman and El-Sheikh [3] proposed the formability stress index, β which describes the effects of the hydrostatic and the effective stress on the PM compacts. Narayanasamy et al. [4] presented experimental work on workability behaviour of Aluminium, Al-Al₂O₃, Al-Fe, Fe, Fe-TiC and Fe-C composites during cold upsetting. The study evaluates the effects of particle size and volume fraction of SiC additions in Al-SiC preforms on workability characteristics. It is reported that β increases with increase in SiC volume percent. Hassani et al. [5] conducted compressive workability tests of porous Al/SiC composites fabricated through mechanical alloying (MA). It was concluded from this study that the instantaneous density coefficient and work hardening exponent decreased when the density was increased. Also, the strength increases with an increase in the milling time, weight percent of SiC particles and a decrease in the SiC particle size. Furthermore, Narayanasamy et al. [6] carried out experimental investigation to understand the